ANALOG DEVICES

CMOS 8-Bit Multiplying D/A Converter

FEATURES
- Low Cost
- Fast Settling: 100ns
- Low Power Dissipation
- Low Feedthrough: ½LSB @ 200kHz
- Full Four-Quadrant Multiplying

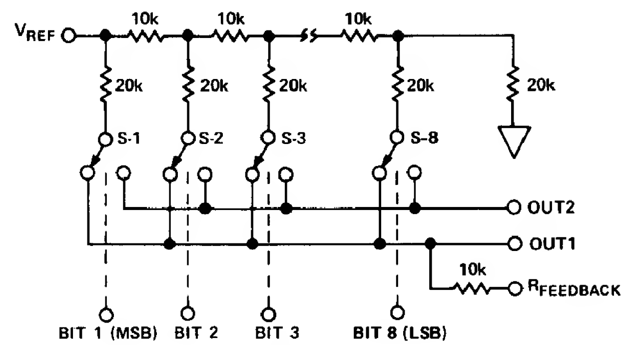
APPLICATIONS
- Battery Operated Equipment
- Low Power, Ratiometric A/D Converters
- Digitally Controlled Gain Circuits
- Digitally Controlled Attenuators
- CRT Character Generation
- Low Noise Audio Gain Control

GENERAL DESCRIPTION

The AD7523 is a low cost, monolithic multiplying digital-to-analog converter packaged in a 16-pin DIP. The device uses an advanced monolithic, thin-film-on-CMOS technology to provide 8-bit resolution with accuracy to 10-bits and very low power dissipation.

The AD7523's excellent multiplying characteristics and low cost allow it to be used in a wide ranging field of applications such as: low noise audio gain control, CRT character generation, motor speed control, digitally controlled attenuators, etc.

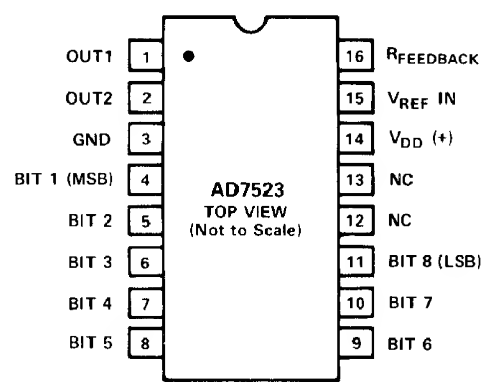
FUNCTIONAL DIAGRAM



ORDERING INFORMATION

Model	Linearity	Package	Operating Temperature Range
AD7523JN	±1/2LSB	16 pin Plastic	0 to +70°C
AD7523KN	±1/4LSB		
AD7523LN	±1/8LSB		

PIN CONFIGURATION



NC = NO CONNECT

One Technology Way; P. O. Box 9106; Norwood, MA 02062-9106 U.S.A.
Tel: 617/329-4700 Twx: 710/394-6577
Telex: 924491 Cables: ANALOG NORWOODMASS

SPECIFICATIONS (V_{DD} = +15V, V_{REF} = +10V unless otherwise noted)

PARAMETER	T_A = +25°C	T_A = T_{min} to T_{max}	TEST CONDITION
STATIC ACCURACY			
Resolution	8 Bits min	8 Bits min	
Nonlinearity[1]			
AD7523JN	±1/2LSB max (±0.2% FSR max)	±1/2LSB max (±0.2% FSR max)	V_{OUT1} = V_{OUT2} = 0V
AD7523KN	±1/4LSB max (±0.1% FSR max)	±1/4LSB max (±0.1% FSR max)	
AD7523LN	±1/8LSB max (±0.05% FSR max)	±1/8LSB max (±0.05% FSR max)	
Monotonicity	Guaranteed over T_{min} to T_{max}		V_{OUT1} = V_{OUT2} = 0V
Gain Error[1,2,3]	-1.5% of FSR min, +1.5% of FSR max	-1.8% of FSR min, +1.8% of FSR max	Digital Inputs = V_{INH}
Power Supply Rejection (Gain)[1,2]	0.02% per % max	0.03% per % max	V_{DD} = +14V to +15V Digital Inputs = V_{INH}
Output Leakage Current			
I_{OUT1} (pin 1)	±50nA max	±200nA max	V_{OUT1} = V_{OUT2} = 0V, V_{REF} = ±10V Digital Inputs = V_{INL}
I_{OUT2} (pin 2)	±50nA max	±200nA max	V_{OUT1} = V_{OUT2} = 0V, V_{REF} = ±10V Digital Inputs = V_{INH}
DYNAMIC PERFORMANCE			
Output Current			
Settling Time[4]	150ns max	200ns max	To 0.2% FSR, Load = 100Ω Digital Inputs = V_{INH} to V_{INL} or V_{INL} to V_{INH}
Feedthrough Error[4]	±1/2LSB max	±1LSB max	Digital Inputs = V_{INL} V_{REF} = 20V p-p, 200kHz sinewave
REFERENCE INPUT			
Input Resistance (pin 15)	5kΩ min, 20kΩ max		V_{OUT1} = V_{OUT2} = 0V
Temperature Coefficient		-500ppm/°C max	
ANALOG OUTPUTS[4]			
Output Capacitance			
C_{OUT1} (pin 1)	100pF max	100pF max	Digital Inputs = V_{INH}
C_{OUT2} (pin 2)	30pF max	30pF max	
C_{OUT1} (pin 1)	30pF max	30pF max	Digital Inputs = V_{INL}
C_{OUT2} (pin 2)	100pF max	100pF max	
DIGITAL INPUTS			
Logic Thresholds			
V_{INH}	+14.5V min	+14.5V min	
V_{INL}	+0.5V max	+0.5V max	
Input Leakage Current			
I_{IN} (per input)	±1μA max	±1μA max	V_{IN} = 0V or +15V
Input Capacitance			
C_{IN}[4]	4pF max	4pF max	
Input Coding	Unipolar Binary of Offset Binary (see next page)		
POWER REQUIREMENTS			
V_{DD} Range	+5V min, +16V max	+5V min, +16V max	Device Functionality. Accuracy is tested and guaranteed only at V_{DD} = +15V
I_{DD}	100μA max	100μA max	Digital Inputs = V_{INH} or V_{INL}

NOTES:
[1] FSR is Full Scale Range.
[2] Using internal feedback resistor, Full Scale Range (FSR) is equal to (V_{REF} - 1LSB) in the unipolar circuit on the next page.
[3] Max gain change from +25°C to T_{min} or T_{max} is ±0.3% FSR.
[4] Guaranteed by design. Not subject to test.

Specifications subject to change without notice.

ABSOLUTE MAXIMUM RATINGS

(T_A = +25°C unless otherwise stated)

V_{DD} to GND . . . . −0V to +17V
V_{REF} to GND . . . . ±25V
Digital Input Voltage (V_{IN}) to GND . . −0.3V to V_{DD} +0.3V
V_{OUT1}, V_{OUT2} to GND . . . . −0.3V to V_{DD}

Power Dissipation (Package)
To +70°C 670mW
Derate above +70°C by . . . . 8.3mW/°C
Operating Temperature Range . . . . 0 to +70°C
Storage Temperature Range . . . . −65°C to +150°C
Lead Temperature (Soldering, 10sec) . . . . +300°C

CAUTION:

ESD (Electro-Static Discharge) sensitive device. The digital control inputs are diode protected; however, permanent damange may occur on unconnected devices subject to high energy electrostatic fields. Unused devices must be stored in conductive foam or shunts. The protective foam should be discharged to the destination socket before devices are removed.

BASIC OPERATION

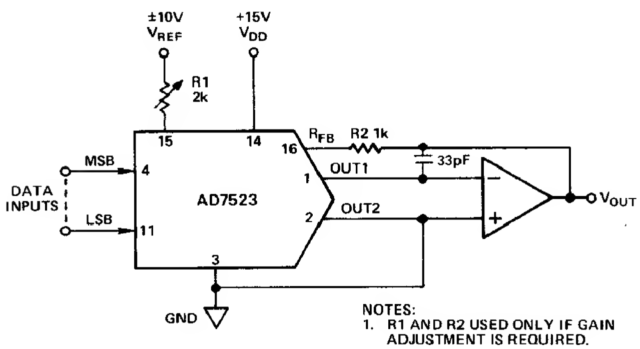


Figure 1. Unipolar Binary Operation (2-Quadrant Multiplication)

DIGITAL INPUT (MSB … LSB)	ANALOG OUTPUT
11111111	$-V_{REF}\left(\frac{255}{256}\right)$
10000001	$-V_{REF}\left(\frac{129}{256}\right)$
10000000	$-V_{REF}\left(\frac{128}{256}\right) = -\frac{V_{REF}}{2}$
01111111	$-V_{REF}\left(\frac{127}{256}\right)$
00000001	$-V_{REF}\left(\frac{1}{256}\right)$
00000000	$-V_{REF}\left(\frac{0}{256}\right) = 0$

Note: $1LSB = (2^{-8})(V_{REF}) = \left(\frac{1}{256}\right)(V_{REF})$

Table I. Unipolar Binary Code Table

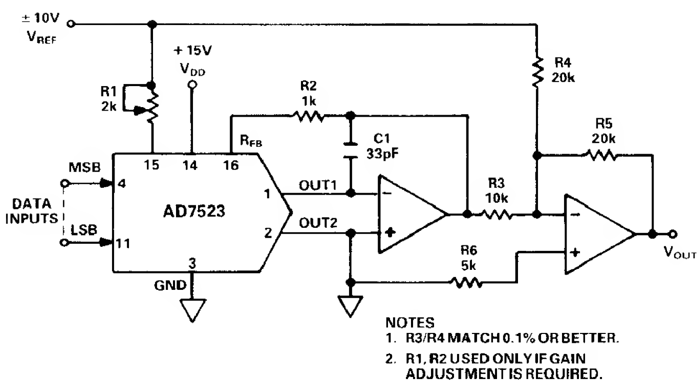


Figure 2. Bipolar (4-Quadrant) Operation

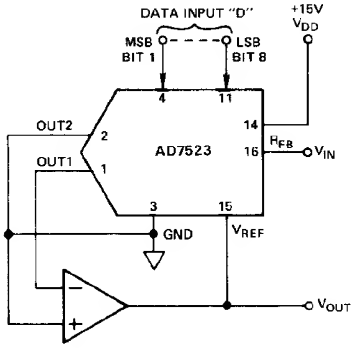
DIGITAL INPUT (MSB … LSB)	ANALOG OUTPUT
11111111	$-V_{REF}\left(\frac{127}{128}\right)$
10000001	$-V_{REF}\left(\frac{1}{128}\right)$
10000000	0
01111111	$+V_{REF}\left(\frac{1}{128}\right)$
00000001	$+V_{REF}\left(\frac{127}{128}\right)$
00000000	$+V_{REF}\left(\frac{128}{128}\right)$

Note: $1LSB = (2^{-7})(V_{REF}) = \left(\frac{1}{128}\right)(V_{REF})$

Table II. Bipolar (Offset Binary) Code Table

APPLICATIONS

DIVIDER (DIGITALLY CONTROLLED GAIN)



EQUATIONS

$$V_{OUT} = -\frac{V_{IN}}{D}$$

$$A_V = \frac{V_{OUT}}{V_{IN}} = -\frac{1}{D} \quad \text{where: } A_V = \text{Voltage Gain}$$

and where:

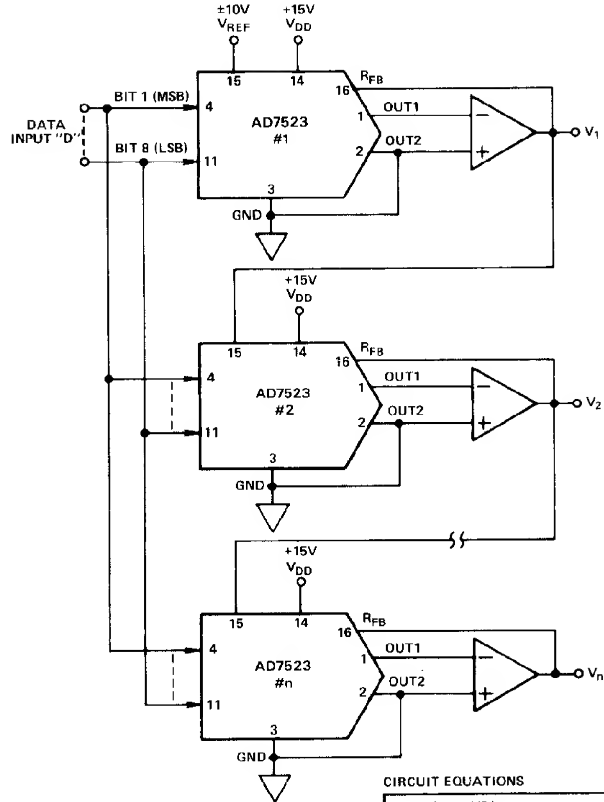
$$D = \frac{\text{BIT 1}}{2^1} + \frac{\text{BIT 2}}{2^2} + \frac{\text{BIT 8}}{2^8}$$

(BIT N = 1 or 0)

EXAMPLES

$D = 00000000$, $A_V = -A_{OL}$ (OP AMP)
$D = 00000001$, $A_V = -256$
$D = 10000000$, $A_V = -\frac{256}{128} = -2$
$D = 11111111$, $A_V = -\frac{256}{255}$

POWER GENERATION



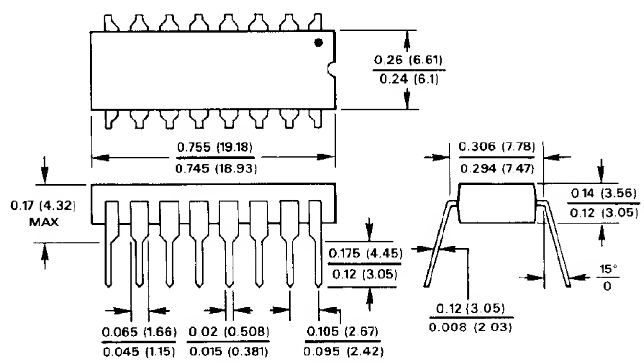
CIRCUIT EQUATIONS

$V_1 = -(V_{REF})(D)$
$V_2 = +(V_{REF})(D^2)$
$V_n = -(V_{REF})(D^n)$, n an odd integer
$V_n = +(V_{REF})(D^n)$, n an even integer

OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

16 PIN PLASTIC DIP



1. LEAD NO. 1 IDENTIFIED BY DOT OR NOTCH
2. LEADS ARE SOLDER PLATED KOVAR OR ALLOY 42.